Engineering Specification
Electrical

EP 05 00 00 01 SP

SUBSTATION AUXILIARY TRANSFORMER FROM RECTIFIER TRANSFORMER SECONDARY

Version 2.1

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Transport NSW RailCorp

Engineering Specification

Document control

Version	Date	Summary of change
	August 2002	Last Technical Review
2.0	May 2010	Application of TMA 400 format
2.1	April 2013	Update template

Contents

1 Introduction

This document details the whole of life performance requirements for the purchase and maintenance of a substation indoor auxiliary transformer that is supplied from one of the 600 V secondary windings of a rectifier transformer. The substation auxiliary transformer provides the supply for the auxiliary services in RailCorp traction substations.

This document does not cover auxiliary transformers supplied from a rectifier transformer with 2420 V secondary windings or auxiliary transformers that are supplied from a high voltage busbar. Auxiliary transformers with a three-phase 220 V secondary winding are also not covered.

2 Scope and Application

The requirements of this document apply from this document's date-of-issue to all new auxiliary transformers that are supplied from one of the 600 V secondary windings of a rectifier transformer.

3 References

3.1 Australian Standards

The following Australian Standards are either referenced in this document or can provide further information.

AS 1939: 1990	*Degrees of protection provided by enclosures for electrical equipment (IP Code).*
AS 2374.1:1997	*Power transformers Part 1: General.*
AS 2374.2:1997	*Power transformers Part 2: Temperature rise.*
AS 2374.3:1982	*Power transformers Part 3.0: Insulation levels and dielectric tests - General requirements.*
AS 2374.3.1:1992	*Power transformers Part 3.1: Insulation levels and dielectric tests - External clearances in air.*
AS 2374.5:1982	*Power transformers Part 5: Ability to withstand short-circuit.*
AS 2374.6:1994	*Power transformers Part 6: Determination of transformer and reactor sound levels.*
AS 2700:1985	*Colour standards for general purposes.*
AS 2735:1984	*Dry-type power transformers.*
AS/NZS 61000.3.6:2001	*Electromagnetic Compatibility (EMC) Part 3.6: Limits - Assessment of emission limits for distorting loads in MV and HV power systems (IEC 61000-3-6:1996, MOD)*

3.2 RailCorp documents

EP 02 00 00 01 SP "Transformer Loss Evaluation".

EP 12 10 00 10 SP "System Substation Earthing".

3.3 Drawings

The following drawings form part of this document:

None.

4 Definitions and abbreviations

For the purpose of this document the definitions given in AS 2374 apply. In addition the following definitions also apply:

Primary winding The winding that receives the active power from the supply system, usually the winding having the highest rated voltage.

Principal tapping Is the mean tapping position. It is also the tapping to which the rated quantities are related.

Secondary winding The winding that delivers the active power to the load circuit, usually the winding having the lowest rated voltage.

5 Introduction

The 1500 V traction system is unearthed, therefore the secondary of the rectifier transformer and the primary of the auxiliary transformer cannot be earthed. Special design considerations are required to ensure that the transformer will not be affected by faults on the traction system.

6 Functional characteristics

6.1 General

The substation auxiliary transformer provides the supply for the auxiliary services in RailCorp traction substations. The transformer primary winding is supplied from one of the secondary windings of a rectifier transformer. The rectifier transformer supplies a series bridge rectifier for the 1500 V traction system.

The auxiliary services include lighting, low voltage power, dc power supplies, ventilation and compressed air. They are not used for supplying dc traction loads. The auxiliary services may be three-phase 415 V or single phase 240 V.

The traction substations are in the area bounded by Newcastle (north), Dapto (south) and Lithgow (west).

6.2 Whole-of-life cost

The selection of the most suitable transformer shall be made on the basis of minimising the whole-of-life cost. The following factors must be considered in determining this:

- Initial purchase price.
- Cost of changes to the Technical Maintenance Plan and Service Schedules or the creation of new manuals and schedules.
- Cost of manuals.
- Cost of maintenance.
- Cost of replacement parts.
- Cost of inventory spares.
- Environmental costs.
- Electrical losses. Refer to document EP 02 00 00 01 SP “Transformer Loss Evaluation” for the method of evaluating transformer losses.
- Cost of installation.
- Reliability and cost of failures.
- Cost of modifications to other parts of the installation.
- Lifetime of equipment.
- Discount rate.

- Cost of staff training.
- Cost of decommissioning and disposal.
- Cost of special tools.
- Cost of changes and management of drawings.

7 Performance characteristics

Number of phases	1 or 3.
Frequency	50 Hz.
Type	Indoor, Enclosed dry-type.
Type of cooling	Air natural.
Rated voltages	Primary 600 V_{rms} Secondary 240 V_{rms} (1ϕ) or 415 V_{rms} (3ϕ)
Tappings	Full kVA tappings on the primary winding at $\pm$ 2.5% and $\pm$ 5% of the principal tapping. The tappings shall be controlled by off-circuit bolted links.
System highest voltage	Primary 3.6 kV_{rms} Secondary 1.1 kV_{rms}
System earthing	Non-effectively earthed.
Rated insulation level	Primary 16 kV_{rms} (power frequency) 40 kV_{rms} (lightning impulse) Secondary 5 kV_{rms} (power frequency)
Connection vector symbol	Dyn 1 (three-phase transformer).
Neutral terminal	Star point of lower voltage winding shall be connected to a suitable terminal and fully insulated from earth.
Impedance voltage at rated current and 75°C	Refer to *AS 2374.5*, Table 1.
Sound pressure level	Refer to *AS 2374.6*, Appendix AA.
Special physical characteristics	Refer to section 8.

8 Technical characteristics

8.1 Rated insulation level

The primary winding(s) are connected to the unearthed secondary of the rectifier transformer. During fault conditions, the voltage to earth of this winding can exceed 3.5 kV_{dc}. Special attention is drawn to the rated insulation level requirements in section 7.

8.2 Harmonic voltages

The rectifiers create high harmonic distortion of the current waveform. This distorted current waveform interacts with the impedance of the rectifier transformer resulting in harmonic voltages. The design of the auxiliary transformer must therefore take these harmonic currents and voltages into account.

8.3 Rating plate

The rating plate shall meet the requirements of *AS 2374.1*, Section 7, and shall include a diagram of connections. A terminal marking plate complying with the requirements of *AS 2374.1*, Section ZC7, shall also be attached to the transformer. The plates shall not be attached to a removable cover.

8.4 Terminal arrangement

The three primary winding leads and the four secondary winding leads (two leads per winding for 240 V) shall be brought out from each transformer winding and terminated on screwed terminal studs suitable for use with crimp lugs. The terminals shall be suitably proportioned and marked to the requirements of *AS 2374.1*, Section ZC4. An insulated barrier shall separate the primary terminals and the secondary terminals. The complete arrangement shall be enclosed in the transformer enclosure.

8.5 Enclosure

The transformer shall be enclosed to meet the requirements of *AS 2735* Section 1.5.2.3 and *AS 1939* with a degree of protection of IP21.

A method for securing the input and output cables shall be incorporated into the enclosure.

8.6 Earth terminal

An earthing terminal suitable for the connection of a 70 mm^2 cable shall be located externally on the transformer enclosure.

8.7 Lifting attachments

Suitable lifting lugs shall be provided for lifting the transformer.

8.8 Temperature-rise limits

The transformer shall be capable of continuous operation at rated power without exceeding the maximum temperature-rise limits as specified in *AS 2374.2*, Section 4.2.

8.9 Finish

The transformer enclosure (internal and external) shall be painted with a smooth semi-gloss enamel.

9 Maintenance

The relevant RailCorp Technical Maintenance Plans (TMP) shall be adhered to for the maintenance of the type of transformer. Where a new type of transformer is purchased and installed that is not covered by the TMP, then a new service schedule shall be created and the TMP updated. This shall include:

- The “Maintenance Policy”, defining the practical means of maintaining the equipment.
- The tasks to be performed at each level of maintenance and staff skill levels required.
- Test equipment and tools.

It is preferable that the period for routine maintenance shall not be more frequent than for the types of transformers currently detailed in the RailCorp Technical Maintenance Plan.

10 Tests

10.1 Acceptance tests

Routine tests shall be carried out on each transformer to *AS 2374.1* Section 10.1.1. The results shall be recorded. A record of a test certificate for type tests carried out on a similar transformer to *AS 2374.1* Section 10.1.2 shall also be available for each transformer.

10.2 Periodic tests

Refer to RailCorp Technical Maintenance Plan.

11 Data set associated with the equipment

The following data shall be maintained for each transformer. This data shall be the property of RailCorp and maintained by the Maintenance Provider responsible for the installation in which the transformer is installed.

11.1 Equipment manuals

The Equipment Manuals must be provided for the installation and shall include full instructions for the preventative, surveillance and corrective maintenance, comprehensive fault diagnosis, rectification procedures and staff training requirements. It shall include all drawings needed for the above. All drawings shall show sufficient detail to enable satisfactory maintenance of the equipment.

11.2 Test results

The results of all tests relating to the transformer, including acceptance tests and periodic and corrective maintenance tests, shall be recorded.

11.3 Life cycle costing

All the data and assumptions pertaining to the determination of the whole-of-life cost calculations shall be recorded.

11.4 Technical information

The information listed in the attached Technical Schedule shall be maintained for each transformer.

Appendix A Technical schedule

General details:

Name of the manufacturer	.....	
Serial number	.....	
Year of manufacture	.....	
Rated primary voltage	.....	V
Rated secondary voltage	.....	V
Rated power	.....	kVa
Connection vector symbol	.....	
Maximum temperature rise of windings	.....	°C
Impedance voltage at rated current and 75°C/115°C* (Expressed as percentage of rated voltage)	.....	%
No-load current with rated voltage applied to the principal tapping (Expressed as percentage of rated current)	.....	%
No-load current with 110% of rated voltage applied to the principal tapping (Expressed as percentage of rated current)	.....	%
No-load loss	.....	W
Load loss	.....	W
Type of core steel - hot or cold rolled	.....	
Brand or trade name and grade of core steel	.....	
Flux density based on net cross-section of steel with rated voltage at rated frequency applied to the principal tapping		
– Limbs	.....	T
– Yoke	.....	T
Mass of windings only	.....	kg
Mass of transformer core and windings only	.....	kg
Mass of one transformer complete with metal enclosure	.....	kg
Mean audible sound level	.....	db

Voltage withstand test:

Primary terminals		
– Lighting impulse withstand voltage	.....	kVp
– Power frequency withstand voltage	.....	kVrms
Secondary terminals		
– Power frequency withstand voltage	.....	kVrms

Terminals, minimum clearance in air:

Between phases

- Primary ……..... mm
- Secondary ……..... mm

Phase to earth

- Primary ……..... mm
- Secondary ……..... mm

Is heat-shrink material provided on the primary terminals? * Yes/No

Type of insulating material used for windings …….....

Type of material used for windings - copper or aluminium …….....

Temperature class of insulation …….....

Overall Dimensions

- Length ……..... mm
- Width ……..... mm
- Height ……..... mm

Protective treatment applied to:

- Internal surfaces …….....
- External surfaces …….....

* Cross out where not applicable.

Departures from Specification

Are there any departures from the requirements of this Specification * Yes/No

Departures from the requirements of this Specification must be highlighted.

Appendix B Requirements for Technical Aspects of Tender Evaluation

Evaluation of tenders

Tender submissions will be evaluated based on a number of criteria. One constant criterion is compliance with this specification. The Chief Engineer Electrical requires that persons evaluating the technical aspects of this tender have sufficient technical competence for the task.

Tender evaluation committees shall forward details of persons evaluating the technical aspects of the tender to the Chief Engineer Electrical for concurrence. This will normally be in the form of an email and is to include sufficient detail of the tender and the person to enable the Chief Engineer Electrical to satisfy themself of the merits of the evaluating person. A minimum of 4 weeks notice is required prior to the evaluation of the Tenders.

The Chief Engineer Electrical will advise within 5 working days only if the person is considered technically unsuitable for the technical evaluation.

Acceptance of product

A number of the specifications require acceptance of product at both the factory and at site. The purchaser is to advise the Chief Engineer Electrical the details of the person carrying out the acceptance testing for the concurrence of the Chief Engineer Electrical. A minimum of 4 weeks notice is required prior to the evaluation of the acceptance testing.

The Chief Engineer Electrical will advise only if the person is considered unsuitable for the acceptance testing.

The Chief Engineer Electrical reserves the right to nominate a representative to review and/or attend such acceptance.

Record Keeping

Where product is purchased against this specification, the Chief Engineer Electrical requires that relevant detail be provided so that it can be logged against this specification.

For RailCorp purchases, all records are recorded in Ariba.

Where this specification is utilised by parties external to RailCorp (Alliance parties, etc) then copies of all relevant technical information and evaluation shall be forwarded to the Chief Engineer Electrical for filing against the specification. In addition copies of selected commercial information pertaining to the ongoing support of the product as follows is also required.

- Warranty details
- Spare parts and associated availability
- Product support information.